Forest Products Laboratory

Our mission

We use science and technology to conserve and extend our Nation's forest resources. For almost 100 years, our mission has been to use our Nation's wood resources wisely and efficiently, while at the same time keeping our forests healthy. Many breakthrough technologies that influence the way we live started at the Forest Products Laboratory (FPL).

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100 Years of Service

Forest Products Laboratory

1910 – 2010

Our role and experience

Established in 1910 by the U.S. Department of Agriculture Forest Service, the FPL in Madison, Wisconsin, serves the public as the Nation's leading wood research institute. The FPL is recognized both nationally and internationally as an unbiased technical authority on wood science and use. Our research is concentrated in one location to promote an interdisciplinary approach to problem solving. The FPL cooperates with many universities, industries, and federal and state agencies.

Our areas of expertise

Today, more than 201 scientists and support staff conduct research on expanded and diverse aspects of wood use. Research concentrates on pulp and paper products, housing and structural uses of wood, wood preservation, wood and fungi identification, and finishing and restoration of wood products.

In addition to traditional lines of research, FPL is responding to environmental pressures on the forest resource by using cutting-edge techniques to meet important future challenges:

- Utilization of small-diameter timber
- Nanotechnology
- Biorefinery/bioenergy
- Advanced wood structures
- Advanced composites

March 2010

Life-cycle inventory and assessment research at the Forest Products Laboratory:
Wood products used in building construction

USDA

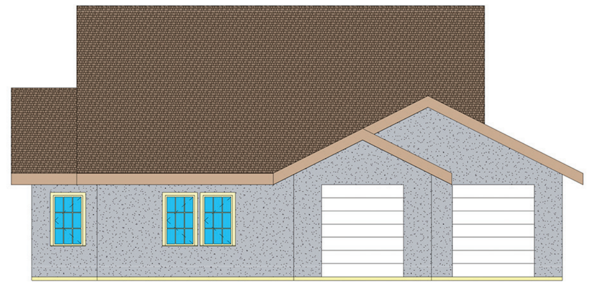
Life-cycle assessment

Wood compared with other non-wood building materials

A life-cycle assessment comparing houses made with wood, steel, and concrete frames was completed using the environmental outputs from completed cradle-to-gate LCIs.[3]

Typical houses for Atlanta and Minneapolis were evaluated. For Atlanta, wood framing was compared with concrete framing. For Minneapolis, wood framing was compared with steel framing.

The Impact Estimator (IE), developed by the ATHENA Institute,[4] prepared the LCAs using product LCIs.



Typical house in Atlanta, Georgia. Source: Danielle F. De Tennis.

The IE simulated the construction of the Atlanta and Minneapolis scenarios using alternative materials and estimated the environmental burdens for each house. All the houses use both wood and non-wood products in their structure.

The IE provides five environmental performance indices:

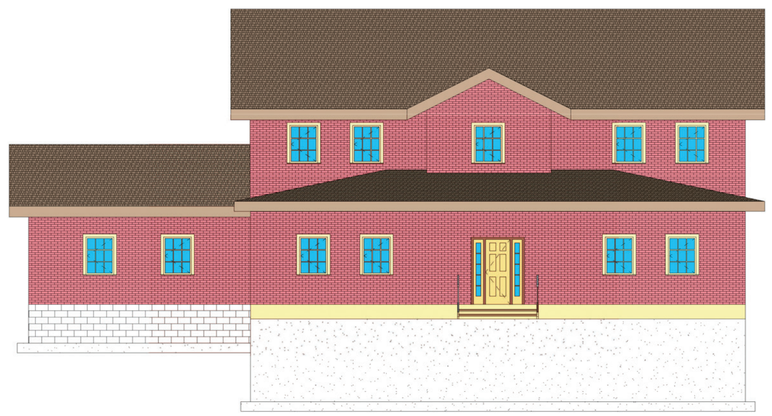
(1) embodied energy,

(2) global warming potential,

(3) air emissions index,

(4) water emissions index, and

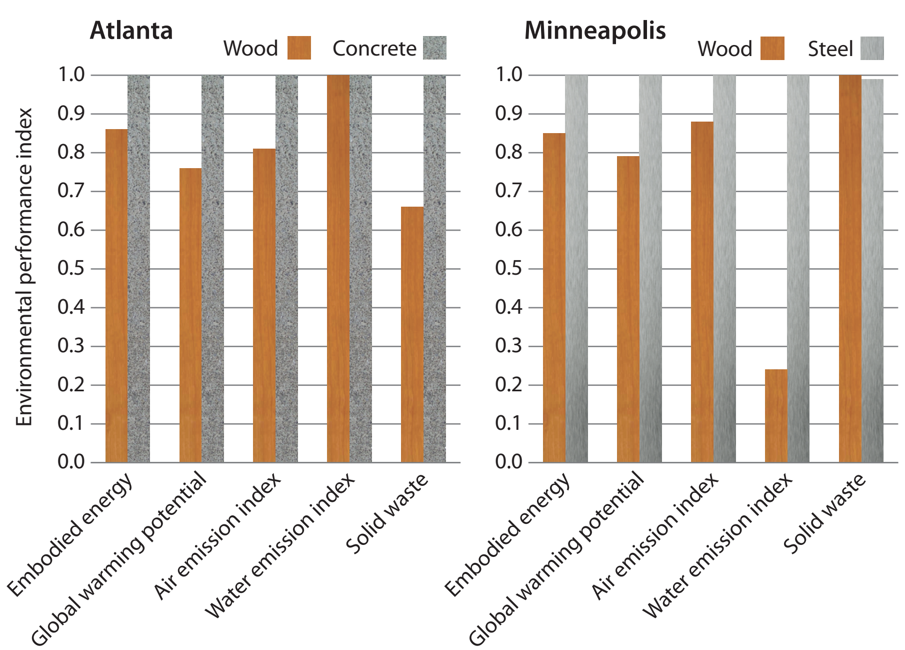
(5) solid waste.



Typical house in Minneapolis, Minnesota. Source: Danielle F. De Tennis.

Environmental performance indices show that wood-framed structures generally have less impact than concrete- or steel-framed structures.

These results indicate that the environmental performance of housing as measured by these indices could be improved by building more wood-framed structures and redesigning houses to incorporate more wood building materials.



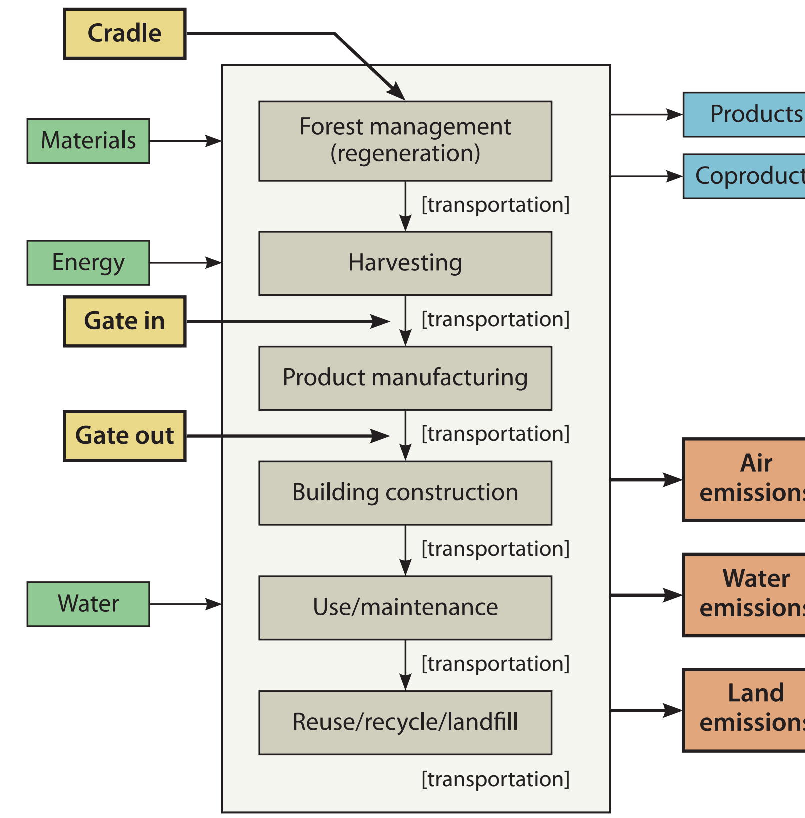
[3] Lippke, B.; Wilson, J.; Perez-Garcia, J.; Bowyer, J.; Meil, J. 2004. CORRIM: Life-cycle environmental performance of renewable building materials. Forest Products Journal 54(6):7–19.

[4] ATHENA Sustainable Materials Institute, Ottawa, Canada, is a cooperator with CORRIM and provided the Impact Estimator, a commercially available software for simulating building construction to generate LCI and environmental measures.

Life-cycle inventory and assessment research at the Forest Products Laboratory: Wood products used in building construction

The purpose of life-cycle research is to determine the environmental burdens—air emissions, water emissions, and land emissions—associated with production and use of particular products. Final measurements of life-cycle environmental performance are units of environmental burden per unit of product produced (for example, kilograms of carbon dioxide emissions per cubic meter of softwood plywood).

Life-cycle research at the Forest Products Laboratory (FPL) focuses on wood products used in building construction and is conducted in collaboration with the Consortium on Research for Renewable Industrial Materials (CORRIM) (www.corrim.org). CORRIM is a group of researchers from more than a dozen organizations, including universities and both government and private research laboratories.



The six life-cycle stages of wood building materials.

Six life-cycle stages, often called life-cycle inventories (LCIs), exist for wood used in building construction—from forest management (regeneration), through product production and use in buildings, to final disposal in landfills. A life-cycle assessment (LCA) uses outputs from the individual LCIs to estimate aggregate environmental impacts such as global warming potential.

CORRIM and FPL are collaborating to develop LCI data for a range of wood products produced in several regions of the United States (such as softwood lumber produced in the Pacific Northwest (PNW), Southeast (SE), and Northeast). The data are stored in a national LCI database (www.nrel.gov/lci) that is managed by the National Renewable Energy Laboratory. This database, available for all to use, contains LCI information on a wide range of wood and non-wood products.

A "gate-to-gate" LCI is the study of a single life-cycle stage, such as hardwood lumber production.[1] "Gate in" has logs entering the sawmill; "gate out" has planed dry lumber leaving the sawmill. LCI information for forest regeneration, wood harvesting, and wood transportation are added to produce a "cradle-to-gate" LCI.

CORRIM prepared cradle-to-gate LCIs for softwood lumber, glulam beams, laminated veneer lumber (LVL), oriented strandboard (OSB), and softwood plywood produced in the PNW and SE regions of the United States.[2]

[1] Bergman, R.D.; Bowe, S.A. 2008. Environmental impact of producing hardwood lumber determined by life-cycle inventory. Wood and Fiber Science 40(3):448–458.

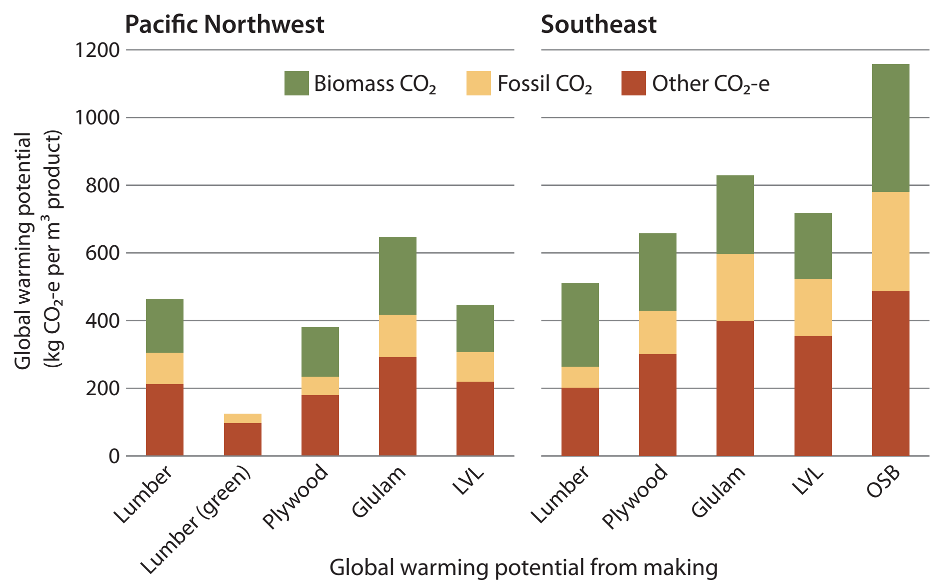
[2] Puettmann, M.E.; Wilson, J.B. 2005. Life-cycle analysis of wood products: Cradle-to-gate LCI of residential wood building materials. Wood and Fiber Science 37:18–29.

Life-cycle inventory data samples

Environmental impact of wood products produced for building construction in the Pacific Northwest and Southeast regions of the United States

Impact on air quality from making wood building materials

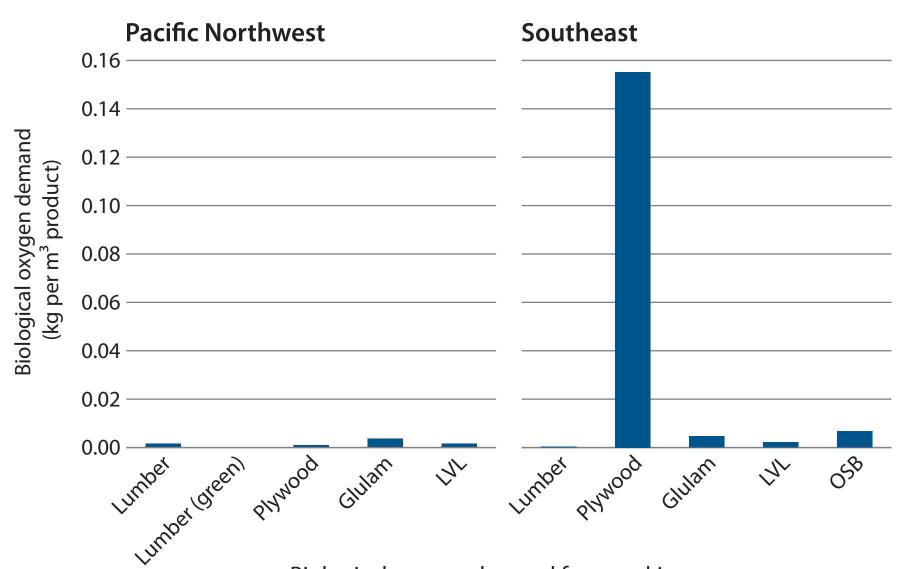
Global warming potential (GWP), in CO_2-equivalent (CO_2-e) emissions per cubic meter of product, includes the effect of several greenhouse gases (GHGs) (carbon dioxide, methane, nitrous oxide, and others). Carbon dioxide is the largest contributor to GHG emissions and comes from burning both biomass and fossil fuels for energy. Manufacturing OSB in the SE has the largest GWP per cubic meter of all the products. Burning wood for energy, mostly for drying wood, is a notable source of GHG emissions. These emissions do not contribute to net GHG emissions as long as forests are capturing carbon faster than the emissions generated from burning wood. Manufacturing green softwood lumber in the PNW has the lowest effect because the lumber is not dried. The GHG emissions from SE products are greater than those from PNW products because half the electric power used in the SE comes from burning coal, whereas the PNW uses a higher percentage of hydroelectric power.



Global warming potential from making different wood building materials.

Impact on water quality from making wood building materials

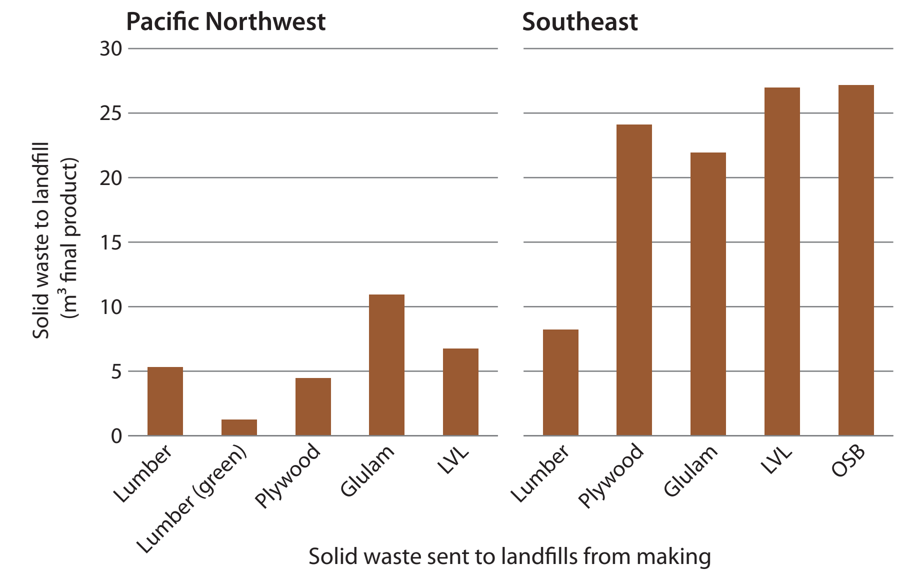
Biological oxygen demand (BOD) is one measure of water emission impacts for various products. Other water emission impacts include dissolved solids, oil, suspended solids, and chemical oxygen demand. High BOD is an indicator of lower water quality. Softwood plywood production in the SE has the highest BOD, although all wood products consuming resin tend to have higher BOD values. Data are still being collected on plywood resins, and the estimates may be modified.



Biological oxygen demand from making different wood building materials.

Impact on land quality from making wood building materials

Solid waste is one type of environmental output to land for various products. Other types of land emissions include inorganic material and wood, which includes paper/board packaging. Recycled material is also tracked. Similar to CO_2-e (air) and BOD (water), solid waste for the SE is higher for all wood building materials in comparison to corresponding material from the PNW. The SE tends to burn more biomass on-site for boiler fuel, thus generating more ash that requires disposal. Consistent with this observation, the SE generates more biomass CO_2 than does the PNW for each building material. Furthermore, PNW green softwood lumber generates roughly 20% less solid waste than PNW kiln-dried softwood lumber. The only difference between the two products is PNW green softwood lumber is not kiln dried. Kiln drying typically requires a boiler for energy, and a boiler that burns wood generates ash.



Solid waste sent to landfills from making different wood building materials.

House construction using wood building materials.

Ongoing applications of life-cycle research

- Determine environmental performance of current and new wood building materials
- Evaluate impact of substituting wood products for products generating more fossil emissions in production and use.
- Aid in developing scientifically sound guidelines for evaluating environmental performance of alternative building designs
- Evaluate environment performance of redesigned houses on a component-by-component basis
- Assess environmental impact of producing biofuels (such as bioethanol and biodiesel) in comparison to transportation fuels (such as gasoline or diesel)
- Compare environmental impacts of disposing of wood after use (landfilling) to alternatives, such as reusing wood building materials.

Examples of wood products in building construction.

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